Review

Focused Assessment With Sonography In Trauma (FAST) In Blunt Abdominal Trauma

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Abstract:

Ultrasound-based clinical diagnosis tools speed up the initial diagnosis of injury, reduce ionizing radiation in Computed tomography (CT) scans, and reduce medical costs. However, the role of Focused assessment with sonography in trauma (FAST) in the diagnosis of intra-abdominal injuries has not been well established. FAST is a rapid procedure and rapid information can be easily obtained in a hemodynamically unstable patient. FAST competes with CT scans in the diagnosis of intra-abdominal injuries; while it is not yet known whether FAST can be used as a tool to identify intra-abdominal injuries and eliminate the need for CT scan before laparotomy, as CT scans would not always be safe in unstable trauma patients. In this narrative we evaluate literature of FAST in different medical situations following the blunt abdominal trauma. Advantages and disadvantages of FAST was discoused for free fluid detection in abdomen and any solid organ injury. Since clinical examination is not reliable to properly assess trauma patients and accepted gold standard methods such as CT scan and Diagnostic Peritoneal Lavage (DPL) are time consuming and invasive, FAST could provide reliable precision for treating hemodynamic patients unstable or more stable. be considered patient.

Keywords: FAST, Focused assessment with Sonography in trauma, Blunt trauma, abdominal trauma

Submitted: 1 November 2021 , Revised: 13 February 2021 , Accepted: 25 April 2021

[DOR: 20.1001.1.23222913.2021.10.3.17.5]

Introduction

Trauma is the leading cause of death in patients under 35 years old and the sixth leading cause of death worldwide. In developing countries, trauma is the leading cause of youth mortality. It is also the most important cause of health-related economic damage in most developing countries [1-3]. There has been a significant reduction in trauma deaths in the last two decades; while undiagnosed damage to the abdomen and its contents remains a common preventable cause of death. Clinical evaluation of patients based on signs, symptoms and laboratory results in the diagnosis and promotion of abdominal trauma control is unreliable [2-6]. A major part of these deaths is happening due to intra-abdominal bleeding following the abdominal trauma, so any action that to help diagnose intra-abdominal bleeding faster would help saving more lives [7]. In all cases of trauma, the first and foremost concern of treatment should be to identify and eliminate anything that may be life threatening [8].

This begins with making sure the airway is open, checking for breathing, and that the person's circulatory system is working properly. These actions are sometimes referred to as "A, B, C" (meaning checking Airway, Breathing, Circulation). This is the first step in any resuscitation or triage of a trauma patient. The history of the accident or injury and any medical history is then collected. The amount of time spent on diagnosis should be decreased without sacrificing diagnostic sensitivity [5-9]. Some diagnostic methods as well as the Diagnostic Peritoneal Lavage (DPL) or ultrasound examination or Focused assessment with sonography in trauma (FAST) are proposed for this aim, before definitive diagnosis in laparotomy [10]. Diagnosing blunt trauma to the abdomen, despite multiple injuries, challenges surgeons. False positive or negative false-positive findings increase the risk of severe complications. FAST is a non-invasive test that can be performed in conjunction with resuscitation. The use of FAST has been taught in Advanced Trauma Life Support (ATLS) and is recommended as a tool for selective screening and early detection in patients with suspected abdominal blunt trauma. FAST is available at almost every trauma center in the United States and other countries that use this ATLS. This procedure is being performed by a simple portable ultrasound device and can be repeated throughout the resuscitation and during any course of treatment. [11-13]. This method has been used as a preliminary triage method for more than 20 years [12,13]. In this paper we review accuracy of FAST in different medical situations of blunt abdominal trauma.

Blunt trauma

Traumatic injuries are divided into two categories based on the mechanism of injury: Penetrating when an object causes skin pierces and bulges and non-penetrating or Blunt trauma. Blunt trauma is a primary injury in which certain types of symptoms, such as burning, pounding, wounds, or bone fractures, occur. Penetrating trauma is a trauma in which an object enters the body like a knife [14]. Most of the serious injuries caused by Blunt trauma are related to vehicle accidents and injuries to pedestrians. Falling downs are also an important cause of mortality, especially in the elderly. Direct kicks, assaults, and sports injuries are also common causes of trauma. The effects of blunt trauma on the body can cause many injuries. The severity of the trauma problem depends on the mechanism and type of injury as well as the patient's physical characteristics. Injuries from blunt trauma can generally be divided into four categories: bruises, scratches, organ tears, and fractures. Blunt injuries are usually examined in forensic anatomy and proper interpretation of injuries is essential for accurate forensic evidence [15]. Compared to penetrating traumas, blunt trauma is typically slower in terms of the force applied to the tissue. This type of trauma is seen in cases of injuries or accidents caused by vehicles. When examining bones that have been broken by a slight force, there are clues that the pathologist can use to identify the condition of the trauma [16]. Blunt trauma is caused by a direct blow of a blunt object to the body. Bruising occurs when, although the skin surface remains intact, the impact causes the capillaries under the skin to rupture, which appear as bruising; While the scratch is caused by the removal of the superficial epidermis. Bruises and scratches may show distinct patterns that can cause a specific wound. For example, a bruise on

[DOR: 20.1001.1.23222913.2021.10.3.17.5]

the front of the head can look like multiple parallel lines or zigzagging. In some trauma cases, there may be rupture damage to internal organs [17]. Depending on the location and type of injury, blunt trauma is potential of leading to internal or external bleeding. The patient's recent bruises are usually red/purple, and as time goes by and they improve, we will see a series of color changes in them. In general, the red/purple combination will be newer than a yellow/ green bruise in the same patient [18-20].

Several pathophysiological mechanisms occur in blunt abdominal trauma. One sudden increase in intra-abdominal pressure or pressure exerted by external forces can cause internal organs to rupture as well as solid organ tearing and hollow viscosity injuries. Blunt forces applied to the anterior abdominal wall can compress the abdomen against the spine, causing the tissue to break. Approximately 80% of traumatic injuries are due to abdominal or pelvic complications or iatrogenic causes, and the remainder are caused by external injuries [17-19]. Solid organs (such as the spleen and liver) are particularly prone to fragility or tear by this mechanism. Elderly and alcoholic patients usually have thinner abdominal walls and are more likely to have such injuries. Spleen rupture may occur postpone. Retroperitoneal structures, such as the duodenum or pancreas, may be injured during this type of trauma. Scissor forces due to a sudden decrease in balance can cause contraction of both solid and hollow viscus organs at the points of connection to the peritoneum. They may also exert blunt force on vascular organs or cause traction damage to the intima and arteries, leading to infarction of sensitive organs. The kidneys are more vulnerable to tearing. Broken ribs or pelvic bones can destroy intra-abdominal tissues [18-20].

Advantages and disadvantages of FAST:

Focused assessment with sonography in trauma (FAST) has many advantages in the initial evaluation of trauma patients, but it also has limitations. This procedure is performed in the patient's bedside and is useful as a screening test, especially in patients who are unable to have a CT scan due to unstable hemodynamics. The presence of free fluid in FAST with unstable hemodynamics that does not respond to resuscitation indicates the need for immediate laparotomy surgery. FAST has several advantages that make it attractive for examining abdominal trauma. This device is relatively inexpensive, portable, radiation-free, and can accurately detect fluid accumulations [21].

Several important limitations prevent the acceptance of FAST as an imaging device for blunt abdominal trauma. Abdominal and posterior peritoneal ultrasound is commonly difficult to see with skin lesions, broken bones, patient restraint, excessive gas in the stomach and intestines. Nowadays, performing FAST along with clinical evaluation is a safe and effective method in examining, diagnosing and deciding on surgery for blunt abdominal trauma. In special cases of multiple trauma and inconsistent and ambiguous findings on FAST, a CT scan is recommended. Of course, the pros and cons of CT scans should be considered in terms of radiation risk [22]. A negative FAST does not completely rule out severe damage to solid or hollow abdominal organs, because at least 15% of false negatives have been reported. In FAST, about 25 percent of liver and spleen lesions, and most kidney, retroperitoneal, pancreatic, mesenteric, and bladder lesions, remain undiagnosed. FAST is useful in reducing CT scans in patients with a low

[DOR: 20.1001.1.23222913.2021.10.3.17.5]

probability of abdominal lesions and FAST can be repeated serially based on the patient's clinical condition [23].

A 1998 study by Buzzas et al. compared the effectiveness of FAST performed by surgeons and radiologists in patients with abdominal trauma. Sensitivity, specificity, accuracy or negative predictive value were not significantly different between the two groups. Less significant positive predictive value was found for experiments performed by surgical center physicians, which is related to the lower experience of surgery residents and they must confirm their results using computed tomography [24].

Free fluid detection:

In Fox et al. (2011) study in California, FAST's ability to detect free fluid was examined. There were 431 participants in this study, of which 74 were excluded. In this study, FAST had a sensitivity of 52%, specificity of 96%, positive predictive value of 48% and negative predictive value of 97%, indicating low sensitivity but high specificity of FAST in detecting free fluid in the abdomen [25].

In a 2007 study by Hsu et al. in Australia, the diagnostic value of FAST was also assessed. In this study, sensitivity was 78%, specificity was 97%, positive predictive value was 91% and negative predictive value was 93%. They introduced FAST as an accurate and safe method [26]. In another Australian study, Soundappan et al. examined the ability of FAST to detect free fluid in children. There were 85 patients (39 boys and 26 girls) in this study. In this study, FAST had a sensitivity of 81%, specificity of 100%, positive predictive value of 9% and negative predictive value of 100% [27]. In another study, sensitivity and specificity of ultrasound with CT scan in the diagnosis of free fluid inside Abdominal cavity of patients with blunt abdominal trauma was compared. In this cross-sectional study, all patients with blunt abdominal trauma referred during 2006-2007 were selected. The information obtained from sonography and CT scan was recorded in a questionnaire and was used to determine the diagnostic value of sonography in comparison with CT scan using sensitivity and specificity indices. Out of 100 patients studied, 20% were female and 80% were male. The most common symptom was abdominal pain and then abdominal tenderness. There was a significant difference between different clinical symptoms in terms of the presence of free abdominal fluid and CT scan report (P = 0.017). Sensitivity, specificity, positive and negative predictive value of ultrasonography in the diagnosis of free abdominal fluid was 84%, 86%, 91% and 75%, respectively [28].

In 1998, a study entitled Early Diagnosis of Abdominal Trauma Kretschmer et al. concluded that in Europe, ultrasonography in the initial examination of polytraumatic patients with possible abdominal trauma replaced the peritoneal lavage method (DPL). Unstable hemodynamic patients with blunt abdominal trauma who were brought to the emergency department after a rapid ultrasound examination with evidence of hemoperitoneum were taken directly to the operating room. They concluded that in patients with stable hemodynamics, in addition to ultrasound, computed tomography can be performed [29]. In 2002, Walcher et al. conducted a study on 61 patients with abdominal blunt trauma. In their study, it was concluded that FAST has been proven as a safe and defective method for rapid detection of intraperitoneal fluid [30]. In

[DOR: 20.1001.1.23222913.2021.10.3.17.5]

2001, a study was performed by Bühne et al. on routine use of FAST in polytrauma analysis. In addition to ultrasound, CT was used when the patient did not need emergency surgery and in stable hemodynamic patients (n = 105). They found that in 27 of 105 patients (25.7%), imaging influenced the treatment approach. In the group with ultrasound, the result was more significant and changed the course of treatment of 29 patients, while in the CT method, this number was 12 patients [31].

Solid organ lesions

One of the first studies comparing FAST with CT showed a low sensitivity of 63% for FAST in the diagnosis of solid organ lesions [32]. The lower sensitivity of this method was due to severe damage to solid organs without the presence of free fluid in the abdominal cavity. Since then, in the critical evaluation of FAST, it seems that the rate of false negatives in patients with trauma has been high []. In a retrospective study, Carter et al. reported sensitivity of 22% for FAST in 1,671 unstable patients with blunt abdominal trauma. According to their study, FAST-negative sonography without CT follow-up can lead to missed intra-abdominal injury (IAI) [33].

In 1997, a study by Fartman et al. they concluded that FAST is the standard method in patients with stable as well as unstable abdominal trauma, which in Both groups of patients (patients with stable and unstable status) are used for both rapid diagnosis and secondary follow-up, such as the use of hydration serum. CT scan is an adjunct to ultrasound in the diagnosis of organ lesions. The invasive method (penetration into the abdominal wall) guided by ultrasound has been substituted for diagnostic peritoneal lavage. Laparoscopy was not useful instead of mild abdominal surgery; however, it may be used for an aggressive diagnosis [34].

Conclusion:

FAST is commonly used worldwide as a diagnostic method for detection of intra-abdominal damage following the blunt abdominal trauma. Because the clinical examination is not reliable in the correct assessment of trauma patients and accepted gold standard methods such as CT scan and DPL are time consuming and invasive, reliable accuracy of FAST could be considered for management of patients with unstable hemodynamic or stable patients. If FAST can be used as an alternative to these methods, given its major benefits, a big step will be taken to reduce the time and cost required to examine the injured while maintaining sufficient diagnostic accuracy.

References:

1. Jansen JO, Yule SR, Loudon MA. Investigation of blunt abdominal trauma. Bmj. 2008 Apr 24;336(7650):938-42.
2. Davis JJ, Cohn Jr IS, Nance FC. Diagnosis and management of blunt abdominal trauma. Annals of surgery. 1976 Jun;183(6):672.
3. Brown MA, Casola G, Sirlin CB, Patel NY, Hoyt DB. Blunt abdominal trauma: screening us in 2,693 patients. Radiology. 2001 Feb;218(2):352-8.
4. DiVINCENTI FC, RIVES JD, LABORDE EJ, FLIMEING ID, COHN JR IS. Blunt abdominal trauma. Journal of Trauma and Acute Care Surgery. 1968 Nov 1;8(6):1004-13.
5. Peitzman AB, Makaroun MS, Slasky BS, Ritter PA. Prospective study of computed tomography in initial management of blunt abdominal trauma. The Journal of trauma. 1986 Jul 1;26(7):585-92.
6. Hoffmann RE, Nerlich MI, Muggia-Sullam MI, Pohlemann T, Wippermann BU, Regel GE, Tscherne HA. Blunt abdominal trauma in cases of multiple

[DOR: 20.1001.1.23222913.2021.10.3.17.5]

trauma evaluated by ultrasonography: a prospective analysis of 291 patients. The Journal of trauma. 1992 Apr 1;32(4):452-8.
7. Stengel D, Rademacher G, Ekkernkamp A, Güthoff C, Mutze S. Emergency ultrasound-based algorithms for diagnosing blunt abdominal trauma. Cochrane Database of Systematic Reviews. 2015(9).
8. Coley BD, Mutabagani KH, Martin LC, Zumberge N, Cooney DR, Caniano DA, Besner GE, Groner JI, Shiels WE. Focused abdominal sonography for trauma (FAST) in children with blunt abdominal trauma. Journal of Trauma and Acute Care Surgery. 2000 May 1;48(5):902-6.
9. Miele V, Piccolo CL, Trinci M, Galluzzo M, Ianniello S, Brunese L. Diagnostic imaging of blunt abdominal trauma in pediatric patients. La radiologia medica. 2016 May 1;121(5):409-30.
10. Goletti O, Ghiselli G, Lippolis PV, Chiarugi M, Braccini G, Macaluso C, Cavina E. The role of ultrasonography in blunt abdominal trauma: results in 250 consecutive cases. The Journal of trauma. 1994 Feb 1;36(2):178-81.
11. Radwan MM, Abu-Zidan FM. Focussed Assessment Sonograph Trauma (FAST) and CT scan in blunt abdominal trauma: surgeon's perspective. African health sciences. 2006 Nov 21;6(3):187-90.
12. Stengel D, Bauwens K, Sehouli J, Porzsolt F, Rademacher G, Mutze S, Ekkernkamp A. Systematic review and meta-analysis of emergency ultrasonography for blunt abdominal trauma. Journal of British Surgery. 2001 Jul;88(7):901-12.
13. Poletti PA, Mirvis SE, Shanmuganathan K, Takada T, Killeen KL, Perlmutter D, Hahn J, Mermillod B. Blunt abdominal trauma patients: can organ injury be excluded without performing computed tomography?. Journal of Trauma and Acute Care Surgery. 2004 Nov 1;57(5):1072-81.
14. Shinkawa H, Yasuhara H, Naka S, Morikane K, Furuya Y, Niwa H, Kikuchi T. Characteristic features of abdominal organ injuries associated with gastric rupture in blunt abdominal trauma. The American journal of surgery. 2004 Mar 1;187(3):394-7.
15. Boulanger BR, McLellan BA. Blunt abdominal trauma. Emergency Medicine Clinics. 1996 Feb 1;14(1):151-69.
16. Abri B, Vahdati SS, Paknezhad S, Alizadeh S. Blunt abdominal trauma and organ damage and its prognosis. Journal of Research in Clinical Medicine. 2016 Dec 24;4(4):228-32.
17. Ciftci AO, Tanyel FC, Salman AB, Büyükpamukcu N, Hiçsönmez A. Gastrointestinal tract perforation due to blunt abdominal trauma. Pediatric surgery international. 1998 Apr;13(4):259-64.
18. TROLLOPE ML, STALNAKER RL, McELHANEY JH, FREY CF. The mechanism of injury in blunt abdominal trauma. Journal of Trauma and Acute Care Surgery. 1973 Nov 1;13(11):962-70.
19. Mehta N, Babu S, Venugopal K. An experience with blunt abdominal trauma: evaluation, management and outcome. Clinics and practice. 2014 Jun;4(2):34-7.
20. Slotta JE, Justinger C, Kollmar O, Kollmar C, Schäfer T, Schilling MK. Liver injury following blunt abdominal trauma: a new mechanism-driven classification. Surgery today. 2014 Feb;44(2):241-6.
21. Quinn AC, Sinert R. What is the utility of the Focused Assessment with Sonography in Trauma (FAST) exam in penetrating torso trauma?. Injury. 2011 May 1;42(5):482-7.
22. Williams SR, Perera P, Gharahbaghian L. The FAST and E-FAST in 2013: trauma ultrasonography: overview, practical techniques, controversies, and new frontiers. Critical care clinics. 2014 Jan 1;30(1):119-50.
23. Osterwalder J, Mathis G, Hoffmann B. New perspectives for modern trauma management–lessons learned from 25 years FAST and 15 years E-FAST. Ultraschall in der Medizin-European Journal of Ultrasound. 2019 Oct;40(05):560-83.
24. Buzzas, G.R., et al., A comparison of sonographic examinations for trauma performed by surgeons and radiologists. Journal of Trauma and Acute Care Surgery, 1998. 44(4): p. 604-608.

[DOR: 20.1001.1.23222913.2021.10.3.17.5]

25. Fox JC, Boysen M, Gharahbaghian L, Cusick S, Ahmed SS, Anderson CL, Lekawa M, Langdorf MI. Test characteristics of focused assessment of sonography for trauma for clinically significant abdominal free fluid in pediatric blunt abdominal trauma. Academic emergency medicine. 2011 May;18(5):477-82.
26. Hsu JM, Joseph AP, Tarlinton LJ, Macken L, Blome S. The accuracy of focused assessment with sonography in trauma (FAST) in blunt trauma patients: experience of an Australian major trauma service. Injury. 2007 Jan 1;38(1):71-5.
27. Soundappan SV, Holland AJ, Cass DT, Lam A. Diagnostic accuracy of surgeon-performed focused abdominal sonography (FAST) in blunt paediatric trauma. Injury. 2005 Aug 1;36(8):970-5.
28. Katz S, Lazar L, Rathaus V, Erez I. Can ultrasonography replace computed tomography in the initial assessment of children with blunt abdominal trauma?. Journal of pediatric surgery. 1996 May 1;31(5):649-51.
29. Kretschmer, K.-H. and H. Häuser, Radiologische Diagnostik des abdominellen Traumas. Der Radiologe, 1998. 38(8): p. 693-701.
30. Walcher, F., et al., Optimierung des Traumamanagements durch präklinische Sonographie. Der Unfallchirurg, 2002. 105(11): p. 986-994.
31. Bühne, K.-H., et al., Routineeinsatz von Abdomensonographie und Oberbauch-CT beim Polytrauma Analyse der Therapierelevanz bei 105 Patienten. Der Chirurg, 2001. 72(1): p. 43-48.
32. McGahan JP, Rose J, Coates TL, Wisner DH, Newberry P. Use of ultrasonography in the patient with acute abdominal trauma. J Ultrasound Med. 1997;16(10):653–662; quiz 663–664.
33. Carter JW, Falco MH, Chopko MS, Flynn Jr WJ, Wiles III CE, Guo WA. Do we really rely on fast for decision-making in the management of blunt abdominal trauma?. Injury. 2015 May 1;46(5):817-21.
34. Farthmann, E., et al., Apparative Diagnostik zur Therapieentscheidung bei Abdominalverletzungen, in Klinik und Forschung in der Chirurgie unter dem Aspekt von Effizienz und Ökonomie. 1997, Springer. p. 406-409.

[DOR: 20.1001.1.23222913.2021.10.3.17.5]